CBCS SCHEME

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15AE43

Fourth Semester B.E. Degree Examination, Feb./Mar. 2022
Aircraft Propulsion

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define and explain Mach number, Reynolds number, Compressible flow and Incompressible flow. **(06 Marks)**

b. Explain with neat diagram, the working principle of four stroke SI engine. **(10 Marks)**

OR

2 a. Differentiate Gas Turbine Engines and Reciprocating engines. **(08 Marks)**

b. Explain principle of aircraft propulsion with an example. **(08 Marks)**

Module-2

3 a. Describe the types of propeller used for aircraft. And explain what is propeller thrust and momentum thrust with equations. **(04 Marks)**

b. Explain with neat sketches the performance characteristics of Turbojet, Turboprop and Turbofan engines. **(12 Marks)**

OR

4 a. What is Thrust? Derive an equation of thrust for a propulsive device and explain the factors affecting thrust. **(10 Marks)**

b. Define with relevant equations:
i) Thrust power ii) Propulsive Efficiency. **(06 Marks)**

Module-3

5 a. Bring out the different types of inlets used for gas turbine engines and explain with neat diagram Bell Mouth shape inlet. **(04 Marks)**

b. Explain the theory of isentropic flow through a convergent nozzle. **(06 Marks)**

c. Air flowing in a duct has a velocity of 300m/s pressure 1.0 bar and temperature 290K. Taking $\gamma = 14$ and $R = 287$ J/kg-K. Determine:
i) Stagnation pressure and Temperature
ii) Velocity of sound in the dynamic and stagnation condition.
iii) Stagnation pressure assuming constant density. **(06 Marks)**

OR

6 a. What are over expanded and under expanded nozzle? Explain. **(02 Marks)**

b. What do you mean by Thrust Reversal? Explain the types of thrust reversals with figures. **(06 Marks)**

c. A supersonic wind tunnel setting chamber expands air (or) Freon-21 through a nozzle from a pressure of 10 bar to 4 bar in the test section. Calculate the stagnation temperature to be maintained in the settling chamber to obtain a velocity of 500m/s in the test section for
i) Air, $C_P = 1.025$kJ/kg K, $C_V = 0.735$kJ/kg K
ii) $F_7 21$, $C_P = 0.785$kJ/kg K, $C_V = 0.67$kJ/kg K
What is the test section Mach number in each case? **(08 Marks)**

Module-4

7 a. Explain the principle of operation of centrifugal compressor. **(08 Marks)**

b. A centrifugal compressor has to deliver 35kg of air per second. The impeller is 76cm diameter revolving at 11,500rpm with an adiabatic efficiency of 80% if the pressure ratio is 4.2:1 estimate the probable axial width of the impeller at the impeller tip if the radial velocity is 120m/s. The inlet conditions are 1 bar and 47°C. **(08 Marks)**

OR

8 a. Explain the performance characteristics of axial flow compressor. **(06 Marks)**

b. An axial flow air compressor of 50% reaction design has blades with inlet and outlet angles of 45° and 10° respectively. The compressor is to produce a pressure ratio of 6:1 with an overall isentropic efficiency of 0.85 when inlet static temperature is out the compressor. Assuming a value of 200m/s for blade speed find the number of stages required if the work done factor is i) Unity ii) 0.87 for all stages. **(10 Marks)**

Module-5

9 a. Describe the process of combustion in a gas turbine and explain classification of combustion chamber with neat diagrams. **(10 Marks)**

b. Explain the effect of operating variables on Burner performance. **(06 Marks)**

OR

10 a. With neat diagram explain

i) Single Stage Turbine

ii) Multistage Turbine. **(06 Marks)**

b. Gas at 7 bar and 300°C expands to 3 bar in an impulse Turbine stage. The nozzle angle is 70° with reference to the exit direction. The rotor blades have equal inlet and outlet angle and the stage operates with optimum blade speed ratio. Assuming that the isentropic efficiency of the nozzle is 0.9 and that the velocity at entry to the stage is negligible, deduce the blade angle used and the mass flow required for this stage to produce 75kW, Take C_P = 1.15kJ/kg K. **(10 Marks)**

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